

# Development of Optics and Detectors for Advanced CMB Polarization Measurements

Completed Technology Project (2013 - 2017)



## Project Introduction

Measurements of the cosmic microwave background (CMB) have been essential to the development of modern cosmology. Future observations will provide cosmological constraints from structure formation as well as improved characterization of inflation in the early universe. Starting in 2008, the Atacama Cosmology Telescope (ACT) measured the CMB temperature on arcminute scales, discovered galaxy clusters through the Sunyaev-Zeldovich effect, and when combined with measurements from NASA's WMAP satellite provided evidence for the existence of dark energy for the first time using CMB measurements alone. With this NSTRF fellowship I plan to work towards the development of optics and detector technologies for a next generation instrument to be deployed on ACT. ACT is a six-meter telescope located in the Atacama Desert in Chile at an elevation of 5190 m. A polarization sensitive upgrade to ACT, known as ACTPol, is now beginning observations. Throughout the length of the fellowship, we will work to implement and observe with ACTPol. We will be able to study the growth of cosmic structure in our universe via detections of galaxy clusters and gravitational lensing of the CMB and will improve constraints on cosmological parameters that describe the early universe. With the use of approximately 3,000 superconducting detectors operating at 90 GHz and 150 GHz, ACTPol will enable high precision measurements of the polarization of the CMB. One of my goals during the fellowship is to help develop a future upgrade to ACT that will provide wider frequency coverage with many more detectors. An important aspect of this project will be research into reading out larger superconducting detector arrays, which could impact technologies for future NASA space missions, such as a next generation X-ray observatory or the Inflation Probe. This as well as research on silicon optics will be conducted in collaboration with researchers at NASA's Goddard Space Flight Center. The optics research is relevant to measurements over a wide range of wavelengths, from far infrared to millimeter wave, and could be used on future NASA missions at these wavelengths. The research conducted under this fellowship will contribute towards improving the technology readiness levels of all the associated technologies for use in future NASA missions.

## Anticipated Benefits

Measurements of the cosmic microwave background (CMB) have been essential to the development of modern cosmology. Future observations will provide cosmological constraints from structure formation as well as improved characterization of inflation in the early universe. This project works toward the development of optics and detector technologies for a next generation instrument to be deployed on the Atacama Cosmology Telescope. The research conducted under this fellowship will contribute towards improving the technology readiness levels of all the associated technologies for use in future NASA missions.



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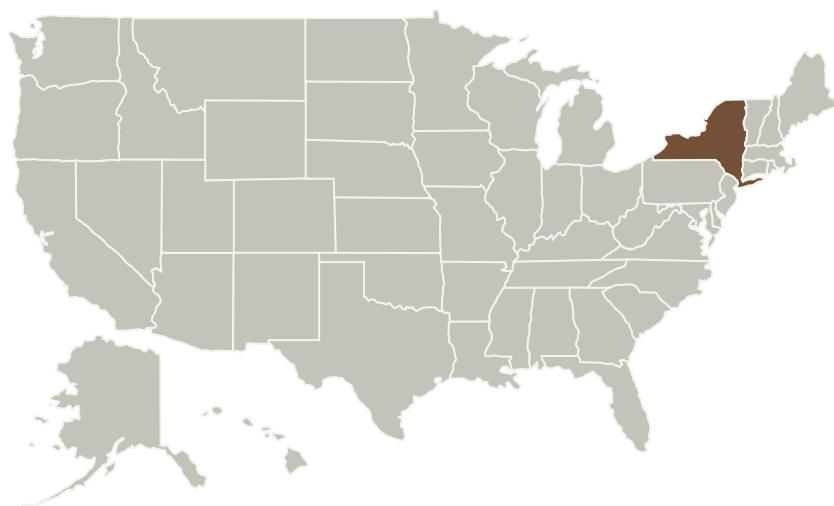
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## Primary U.S. Work Locations and Key Partners



| Organizations Performing Work | Role              | Type     | Location         |
|-------------------------------|-------------------|----------|------------------|
| Cornell University            | Lead Organization | Academia | Ithaca, New York |

### Primary U.S. Work Locations

New York

## Project Website:

<https://www.nasa.gov/directorates/spacetech/home/index.html>

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

Cornell University

### Responsible Program:

Space Technology Research Grants

## Project Management

### Program Director:

Claudia M Meyer

### Program Manager:

Hung D Nguyen

### Principal Investigator:

Michael D Niemack

### Co-Investigator:

Brian Koopman

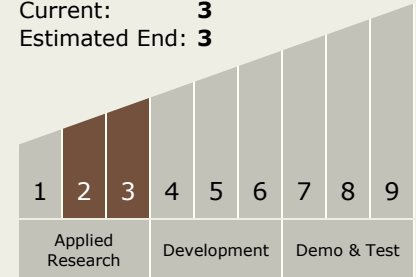
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## Technology Maturity (TRL)

Start: **2**  
Current: **3**  
Estimated End: **3**



## Technology Areas

### Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.1 Detectors and Focal Planes

## Target Destination

Outside the Solar System